

REPORT

2024

The impact of climate change on human health in the Nordic countries

Protocol for a systematic scoping review

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Summary

Climate change, driven predominantly by human activities, poses a critical threat to global health. The consequences of climate change manifest through both direct and indirect effects. Direct effects, such as those from extreme events like heatwaves, floods, and landslides, are acute and easily identifiable. Indirect effects present complex challenges, and can affect food and water safety and security, the prevalence of non-communicable diseases (NCDs), many infectious diseases (IDs), mental health, and the potential displacement of populations (1-3)

Moreover, climate change not only affects individuals but also poses challenges to countries' healthcare delivery systems. The increased frequency of extreme weather events associated with climate change can directly impact healthcare facilities, infrastructure, and the healthcare workforce, hindering the ability to deliver appropriate services and indirectly threatening public health.

Initiatives, including the health program launched during the 26th United Nations Climate Change Conference, emphasize the need for a low-emission and climate-adapted healthcare sector. This systematic scoping review is proposed to map existing literature on climate change and health regarding the Nordic countries, aiming to inform stakeholders and develop projections on the future impact of climate change on health. The study's objectives and aims involve identifying existing documentation, mapping literature on direct and indirect consequences, and assessing evidence for expected future consequences in this region. The systematic review is crucial for conducting risk assessments, vulnerability analyses, and shaping climate resilience strategies to address potential health consequences. The planned interactive research maps will offer a comprehensive overview of the research conducted on how climate change affects human health in the specified region. The full reports will contribute to the growing body of knowledge on the intersection of climate change and public health.

Title:
The impact of climate change on health in the Nordic countries

Protocol for a systematic scoping review

Commissioned date:
August 2023

Due date:
December 2024

Core team:
Ernst Kristian Rødland (teamleader, NIPH)
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Gunn Elisabeth Vist (NIPH)
Anita von Krogh (NIPH)
Norun Hjertager Krog (NIPH)
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Peer reviewers:
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Kristin Aunan, CICERO, Norway.

Approved by:
Kristine Bjerve Gützkow, Head of Department, Air quality and Noise, NIPH
Johan Øvrevik, Research Director, Climate and Environmental Health, NIPH

Sammendrag

Klimaendringer, i hovedsak forårsaket av menneskelige aktiviteter, utgjør en alvorlig trussel mot global helse. Konsekvensene av klimaendringer blir synlige gjennom både direkte og indirekte effekter. Direkte effekter, som for eksempel forårsaket av hetebølger, flom og jordskred, er akutte og lett identifiserbare. Indirekte effekter er mer komplekse og kan påvirke mat- og vannsikkerhet, forekomsten av ikke-smittsomme sykdommer (NCDs), mange smittsomme sykdommer (IDs), mental helse og sannsynlig fordrivelse av befolkninger (1-3).

Videre påvirker klimaendringer ikke bare enkeltpersoner, men utfordrer også helsesystemene. Økt forekomst av ekstreme værhendelser knyttet til klimaendringer kan direkte påvirke helsetjenestefasiliteter, infrastruktur og helsepersonell, noe som kan true evnen til å levere nødvendige tjenester og indirekte true menneskers helse.

Initiativer, inkludert helseprogrammet lansert under FNs 26. klimakonferanse (COP26HP) i 2021, understreker behovet for en lavutslipps- og klimatilpasset helsesektor. Denne systematiske kunnskapsoppsummeringen har som mål å kartlegge eksisterende litteratur om sammenhenger mellom klimaendringer og helse i de nordiske landene, med mål om å informere interessenter og utvikle projeksjoner om fremtidige påvirkninger av klimaendringer på helsen. Studiens mål og formål innebærer å identifisere eksisterende dokumentasjon, kartlegge litteratur om direkte og indirekte konsekvenser, og vurdere forventede fremtidige konsekvenser i denne regionen. Den systematiske gjennomgangen vil gi bidrag til gjennomføring av risikovurderinger, sårbarhetsanalyser og utforme strategier for klimatilpassning for å håndtere mulige helsekonsekvenser. De planlagte interaktive forskningskartene vil gi en omfattende oversikt over forskningen om hvordan klimaendringer påvirker menneskers helse i Skandinavia og regioner med tilsvarende klima. De fullstendige rapportene vil bidra til den voksende kunnskapsbasen om klimaendringer og folkehelse.

Tittel:

Klimaendringer og konsekvenser for helse i Norden

Protokoll for systematisk kartleggingsoversikt

Bestillingsdato:

August 2023

Leveringsfrist:

December 2024

Core team:

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Godkjent av:

Kristine Bjerve Gützkow, avdelingsdirektør, FHI

Johan Øvrevik, fagdirektør, FHI

Background

There is scientific consensus that climate change is happening and that human activities are the main drivers. Continued emission of greenhouse gases will lead to continued global warming, and immediate, substantial and continuous actions are needed to reduce the emissions (4).

Consequences of climate change are acknowledged as among the greatest threats to human health globally (5). The influence of climate change on health can broadly be classified into direct and indirect effects. The direct effects often derive from changes in temperature and precipitation which may expose humans to extreme events such as heatwaves, forest fires, floods and droughts (6). Indirect effects may be equally important as threats to human health and are most often caused by climate change-induced environmental and ecosystem changes. Examples are impact on food- and water security, the prevalence of non-communicable diseases (NCDs), many infectious diseases (IDs), mental health and reduced labor capacity due to increasing temperatures (6). Climate change and its consequences are also expected to render areas populated today inhabitable, resulting in a huge number of internally and externally displaced people, with negative health outcomes for the refugees, and challenges, both for the regions of origin and for recipient countries.

In addition to affecting individuals, groups of people and populations, climate change may hamper countries' ability to deliver healthcare. Assessments on differences in handling the Covid-19 pandemic conclude that a robust healthcare sector is needed for successfully tackling a health crisis. Climate change results in more frequent extreme weather events that can impact the health care facilities directly, destroy infrastructure needed to access healthcare, or impact the healthcare workforce. All could reduce the ability to deliver appropriate services, thus indirectly threatening peoples' health.

Initiatives are in place both to mitigate climate change, and to adapt to the changes that take place. During the 26th United Nations Climate Change Conference, Conference of the Parties (COP), in Glasgow in 2021, the health programme (HP) was launched. COP26HP is an agreement among member states to develop a low-emission and climate adapted healthcare sector in those states signing up. The commitment which Norway has signed together with more than 70 countries implies tasks related to both mitigation and adaptation, of which tasks related to the latter are of primary concern for the present review:

- a) Conducting a vulnerability and risk assessment of climate change induced health threats in the respective member states.
- b) Develop a national adaption plan for the healthcare sector.
- c) Committing to use the vulnerability and risk assessment and the adaption plan to facilitate for financing climate adaption of the healthcare sector.

To document how a changing climate can impact human health, particularly the indirect consequences, is challenging and characterized by complexity. A natural starting point is to identify and document how climate change has impacted the burden of

disease in a region over the last decades. Both to identify knowledge gaps, but also to establish a basis for developing projections on what can be expected in the future. With this scoping review we aim to systematically map the existing literature in the climate and health nexus in the Nordic countries, which leads to more comprehensive assessments on specific topics on the impact of climate change on health. The overall objective is to inform relevant stakeholders in developing projections on the impact of climate change on health in the future.

Why it is important to conduct this systematic review

To conduct risk assessments and vulnerability analyses regarding climate resilience and the potential health consequences of climate change, a comprehensive overview of current knowledge and available literature is essential.

Objective and aims

Objective: Identify existing documentation/scientific literature on the consequences for human health in the Nordic countries associated with climate change.

Aim(1) Map the currently available literature on the direct and indirect consequences of climate change in the Nordic countries on human health.

Aim(2) Map the present literature on the direct and indirect consequences for human health in the Nordic countries caused by effects of climate change globally.

Aim(3) Map the literature on expected climate change induced consequences for human health in the Nordic countries in the future.

Methods

We will conduct this systematic scoping review in accordance with this protocol, the NIPH methods book (7) and the Campbell Collaboration Handbook for evidence and gap maps (8).

Inclusion criteria

Different search criteria were tested in the preparatory phase of this work, and it became quickly apparent that defining health-outcomes was challenging. When summarizing the literature on the effects of climate change on human health, it is problematic to draw the line on what to include or exclude depending on how distant in the causal chain the possible human health effect the study reported on. Publications addressing environmental changes or impacts that clearly lead to challenges for human health were included, even if implications for human health weren't specifically reported on or discussed. Examples are impact on drinking water or soil quality, which may threaten water- or food security. Examples of the former are studies describing an increase in hazardous substances in drinking water related to climate change. In relation to climate change and food safety and security, studies reporting on effects or changes in food humans may use or eat directly were included, even if they did not report directly on human health. Studies reporting on changes further down in the food chain were not included if they did not report on human health effects. Additionally, the climate sensitive vector borne organisms considered relevant for the Nordic context was defined (attachment 1).

The following inclusion criteria were used:

Location	The Nordic countries (Norway, Sweden, Denmark, Finland, and Iceland)
Exposure	Climate change effects: <ul style="list-style-type: none"> • Extreme weather events • Temperature (Heatwaves, cold spells, average temperature) • Precipitation/humidity • Drought • Flood • Slides and avalanches • Zero degree crossings • Water safety • Water security • Food safety • Food security • Forced displacement • Other

Outcome	Health consequences including: <ul style="list-style-type: none"> • Mortality • Disease burden • Trauma/physical injury • Acute temperature related illness • Infections • Cardiovascular disease • Pulmonary disease • Kidney disease • Immunological • Mental health • Malnutrition • Other
Study design	Any study reporting on a climate event or projecting/modeling one that affects human health or review such studies.
Publication time	No restrictions.
Geography	Any location within the Nordic countries.
Language	No restrictions in the searches, but we will only be able to assess in full text and include studies in Danish, English, Norwegian and Swedish.

Exclusion criteria

We will exclude publications that do not report on actual or projected climate changes and extreme weather events with impact on human health.

Literature search

Searches in databases

Information specialist Marit Johansen will design and conduct the systematic literature search that will be developed in collaboration with the project group. The strategy will be peer reviewed by Gyri Hval (NIPH) before the literature search is conducted. The following databases will be searched, and the MEDLINE-strategy is found in attachment 2:

- Ovid MEDLINE
- Embase
- Web of Science
- CENTRAL

- Epistemonikos
- PsycInfo
- Global Health
- BASE

Additionally, search will be done in Open Polar (<https://openpolar.no/>), and we will search the webpages of relevant organizations and institutes for reports and publications. We will search in documents from the World Health Organization (WHO) and the European Climate and Health Observatory and from the Ministries of Health and the Ministries of Climate and Environment in the different countries. Additionally, for the respective countries:

Sweden:

- The Public Health Agency of Sweden
- Swedish National Knowledge Centre for Climate Change Adaption
- Swedish Government's Climate Policy Framework

Denmark:

- Task Force on Climate Change Adaptation
- Environmental Protection Agency (EPA) and Coastal Authority

Norway:

- The Norwegian Institute of Public Health (NIPH)
- CICERO
- NIBIO
- NORCE
- NINA
- NILU

Finland:

- The Finnish Institute for Health and Welfare (THL)

Additionally, we will check references of relevant systematic reviews and other key publications.

Selection of studies

Members of the core team will read and assess the reference identified in the literature searches independently and in pairs. Relevant references will be selected according to our inclusion criteria. The first selection will be based on the title and abstract. Selection on full-text evaluation of the publications will also be conducted by two people independently. Any disagreements will be resolved through discussion or contact with another researcher in the team. EPPI Reviewer 6 will be used for this systematic scoping review (9).

Data collection and presentation of the included studies

One author from the core team will collect data from the studies and another author with relevant expertise from the core team or the extended working group (attachment 3) will check that the relevant information is correctly extracted. Disagreements will be solved by consensus. We will collect information on the full reference, when and where and how it was conducted, what type of climate event, who was involved and the health consequences that were considered.

We plan to present two separate maps. The first map will include publications on health consequences associated with climate events that have happened, the second one will include publications on health consequences from climate model projections.

These interactive research maps will give an overview of scope and type of research that has been conducted on how climate changes affect human health in the Nordic countries. These interactive research maps will present the studies in categories and subcategories, and we will describe them in text and tables as well. Attachment 4 shows our planned code book with suggested categories, and we may expand on the categories during our work with the literature.

Peer review of protocol and publishing of the full report

Peer reviewers:

Trude Storelvmo, Dept. of Geosciences, University of Oslo, Norway.

Kristin Aunan, CICERO, Norway.

The protocol will be approved by Head of Department, Air Quality and Noise, Kristine Bjerve Gützkow and Research Director Johan Øvrevik.

Final report will be published.

Time schedule

Start: 01.09.2023

Delivery: 15.12.2024

Related projects at NIPH

Norwegian Institute of Public Health (NIPH) (2023). Folkehelse rapporten 2023: Helse-tilstanden i Norge. Folkehelseinstituttet. <https://www.fhi.no/he/folkehelse-rapporten/?term=>

Norwegian Institute of Public Health (NIPH) (2023). Klimaendringer: Sårbarhet og tilpasningsbehov i helse og omsorgssektoren i Norge. Rødland EK, Nerhus KA, Brasfield DV, Shelil MEA. <https://www.fhi.no/publ/2023/klimaendringer---sarbarhet-og-tilpasningsbehov-i-helse--og-omsorgssektoren-/>

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2. World Health Organization (WHO). Mental health and climate change: policy brief. 2022.
3. Romanello M, Napoli CD, Green C, Kennard H, Lampard P, Scamman D, et al. The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. *Lancet*. 2023.
4. IPCC. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland; 2023.
5. WHO. Climate change and health 2021 [Fact sheet]. Available from: <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>.
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7. FHI. Slik oppsummerer vi forskning [nettdokument]: FHI; [Available from: <https://www.fhi.no/nettpub/metodeboka/>].
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9. Thomas J, Grazosi S, Brunton J, Ghouze Z, O'Driscoll P, Bond M, et al. EPPI-Reviewer: advanced software for systematic reviews, maps and evidence synthesis. [Manual]. UCL Social Research Institute, University College London; 2022 [Available from: <https://eppi.ioe.ac.uk/cms/er4/Manuals/FAQ/tabid/3384/Default.aspx>].

Attachment 1, Vector-borne organisms considered relevant for the Nordic countries

Organism	Vector/host	Disease
<i>Borrelia burgdorferi</i>	Ticks	Borreliosis
<i>Dirofilaria immitis</i>	Mosquitoes	Heartworm disease
<i>Puumala orthohantavirus</i>	Voles	Nephropatia epidemica
<i>Francisella tularensis</i>	Mosquitoes (hares, rodents)	Tularemia, «hare fever»
West Nile virus (WNV)	Mosquitoes	West Nile fever
Tick-borne encephalitis virus (TBEV)	Ticks	Tick borne encephalitis
<i>Babesia</i>	Ticks	Babesiosis
Influenza A virus	Birds	Avian Influenza
<i>Echinococcus multilocularis et granulosis canadensis</i>	Carnivorous mammals	Ecchinococcosis
Rift Valley Fever virus (RVFV)	Mosquitoes	Rift valley fever

Attachment 2, Medline-search strategy

Ovid MEDLINE(R) ALL 1946 to February 14, 2024

#	Searches	Results
1	Climate Change/	27967
2	Global Warming/	4568
3	Greenhouse Gases/	2725
4	Greenhouse Effect/	6223
5	Natural Disasters/	579
6	exp Extreme Weather/	167
7	Temperature/	267036
8	Hot Temperature/	126103
9	Cold Temperature/	55535
10	Extreme Heat/	651
11	Extreme Cold/	141
12	Droughts/	12679
13	Wildfires/	1326
14	Rain/	12210
15	Humidity/	18133
16	Floods/	4190
17	Tidal Waves/	383
18	Tsunamis/	1054
19	Sea Level Rise/	154
20	Landslides/	297
21	Avalanches/	221
22	Cyclonic Storms/	3100
23	Tornadoes/	238
24	Soil Erosion/	149
25	(climat* and (change* or warming or effect* or impact* or hazard* or crisis or challenge*)).ti.	21910
26	(climat* adj6 (change* or warming or effect* or impact* or hazard* or crisis or challenge*)).ab,kf.	80242
27	(climate mitigation or climate resilience or climate resilient or climate related).ti,ab,kf.	2795

28	((extreme* or sever* or heavy or exceptional*) and (weather or heat or cold or temperature* or rain* or wind* or precipitation or humidity)).ti.	4544
29	((extreme* or sever* or heavy or exceptional*) adj6 (weather or heat or cold or temperature* or rain* or wind* or precipitation or humidity)).ab,kf.	36239
30	(temperature increase* or increase* temperature* or rising temperature* or humid temperature or hot humidity or global warming or greenhouse effect* or greenhouse gas* or heat wave* or heatwave* or cold wave* or coldwave* or cold spell* or coldspell* or desertification or drought* or wildfire* or wild fire* or wildland fire* or forest fire* or bush fire* or flooding or waterlogging or water logging or tidal wave* or sea level ris * or rising sea level* or rising water level* or erosion or landslide* or land slide* or rockslide* or rock slide* or mudslide* or mud slide* or avalanche* or cyclon* or storm* or hurricane* or typhoon* or tornado*).ti,ab,kf.	171551
31	or/1-30 [CLIMATE CHANGE]	686757
32	exp Health/	447395
33	exp "Health Care Facilities, Manpower, and Services"/	3388468
34	exp Diseases/ or exp Cardiovascular Diseases/ or exp Chemically-Induced Disorders/ or exp "Congenital, Hereditary, and Neonatal Diseases and Abnormalities"/ or exp Digestive System Diseases/ or exp "Disorders of Environmental Origin"/ or exp Endocrine System Diseases/ or exp Eye Diseases/ or exp "Hemic and Lymphatic Diseases"/ or exp Immune System Diseases/ or exp Infections/ or exp Musculoskeletal Diseases/ or exp Neoplasms/ or exp Nervous System Diseases/ or exp "Nutritional and Metabolic Diseases"/ or exp Occupational Diseases/ or exp Otorhinolaryngologic Diseases/ or exp "Pathological Conditions, Signs and Symptoms"/ or exp Respiratory Tract Diseases/ or exp "Skin and Connective Tissue Diseases"/ or exp Stomatognathic Diseases/ or exp Urogenital Diseases/ or exp "Wounds and Injuries"/ or exp Mental Disorders/	17752534
35	(health* or disease* or disorder* or illness* or sickness* or trauma* or injury or injuries or stress or malnutrition or epidemic* or pandemic* or wellbeing or well being or wellness or prescrip* or prescrib* or drug utilization or "drug use" or hospital* or mortality or morbidity or death*).ti,ab,kf,hw.	15746788
36	or/32-35 [HEALTH]	23283278
37	Food Security/	751

38	Food Insecurity/	1610
39	Food Supply/	16032
40	Drinking Water/	12414
41	Water Insecurity/	96
42	Water Supply/	34862
43	Water Pollution/	14530
44	Water Quality/	9753
45	Air Pollution/	41240
46	(food adj (securit* or insecurit* or supply or supplies)).ti,ab,kf.	27048
47	(drink* water or water supply or water supplies).ti,ab,kf.	71710
48	(air pollution or polluted air or air quality or water pollution or polluted water or water quality).ti,ab,kf.	90160
49	or/37-48 [FOOD - WATER - AIR CONSEQUENCES]	234457
50	"Scandinavian and Nordic Countries"/ or Denmark/ or Greenland/ or Finland/ or Iceland/ or Norway/ or Svalbard/ or Sweden/	223098
51	Arctic Regions/	7580
52	(arctic or subarctic or scandinavia* or nordic countr* or denmark or faroe islands or danish or greenland* or finland or lapland or lappland or finnish or iceland or icelandic or norway or norwegian or svalbard or sweden or swedish or saami or sapmi).ti,ab,kf.	260245
53	or/50-52 [NORDIC and ARCTIC]	345918
54	(climate anxiety or eco anxiety or ecoanxiety or ecological anxiety or (fear adj2 climate change)).ti,ab,kf.	143
55	31 and 36 and 53	3116
56	31 and 49 and 53	536
57	53 and 54	4
58	Animals/ not (Animals/ and Humans/)	5163191
59	55 not 58	2494
60	56 not 58	469
61	57 not 58	4
62	or/59-61	2763

Attachment 3, Members of the extended working group

Name	Affiliation
Anita Verpe Dyrdal	Norwegian Center for Climate Services
Mari Steinert	Norwegian Institute of Public Health (NIPH)
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Susanne Hyllestad	NIPH
Anne Lise Brantsæter	NIPH
Nina Iszatt	NIPH

Attachment 4, Code book

<i>Code book for interactive research maps on health consequences associated with climate change in the Nordic countries</i>		
Type of publication		Comments
	Systematic reviews	With search and quality assessment of included studies.
	Non-systematic reviews	Literature search but not quality assessment. No other codes needed.
	Prospective study	
	Retrospective study	
	Case reports	Follow up is "single time event"
	Cross sectional studies	
	Prediction models	Climate and health predictions
	Other reports	For example, developed without a particular focus on health
	Comments or editorials (for later interest) – not shown in map.	No codes needed
Time of event/ time to projection or model		
	Single time event	
	< 5 years	
	5 years to < 20 years	
	≥ 20 years	
	No follow up	
	Future projections (< 10 years and > 10 years)	Short term vs. long term (in other words, the timeframe)
Geography/location		
	Arctic	
	Non-arctic	Mountains
	Coastal	
	Inland	
Population		
	All humans including children, adolescents, adults and elderly	No age limit
	Children < 16 years	
	Adolescents 16-24 years	
	Adults 25-64 years	
	Elderly ≥ 65 years	
	Indigenous people	In Norway, Sami people
	Pregnant and infants	
	Not specified	
Climate related changes		
	Changes in temperature	
	Heat/heatwaves	
	Changes in precipitation	
	Floods	

	Droughts	
	Landslides/avalanches	
	Sub-zero temperatures/cold spells	
	Other	
Health consequences		
	Trauma/physical injury	
	Disease burden	
	Heat stroke	
	Infections	All infections, also food- and waterborne diseases
	Cardiovascular disease	
	Pulmonary disease	
	Immunological	That is allergy/asthma
	Mental health	
	Malnutrition	
	Mortality	
	Other	
Climate related outcomes associated with adverse health effects		
	Water safety	
	Water security	
	Food safety	
	Food security	
	Forced displacement	
	Other	

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